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Farmers' Awareness of Land Degradation in the Dry Zone Rain-fed Uplands: The Case of Ranpathwila Cascaded Tank Village System, Sri Lanka

S.M.C.B Karalliyadda[1*], T. Kazunari[2], and M. Fujimura[2]

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ABSTRACT

Purpose: *The Rain-fed uplands of Cascaded Tank Village Systems (CTVS) in the Sri Lankan dry zone are degrading while challenging the food security, economy and ecological sustainability of the nation. Farmers' unawareness of land degradation (LD), and irresponsibility for land conservation are often accused of the LD, yet with limited empirical evidence. Therefore, this study aims at providing empirical evidence on farmers' awareness of LD by investigating farmers' perceived indicators and causes of LD i.e., deforestation, soil erosion, soil fertility decline, and their perceived responsibility to halt LD.*

Research Method: *A questionnaire survey was administered among conveniently sampled 291 farmers in the Ranpathiwila CTVS area along with interviews and field observations. Data were analyzed using descriptive statistics including Multiple response analysis in SPSS 18.*

Findings: *Farmers are aware of LD by physically examining and qualitatively assessing the relevant indicators of LD (E.g., onsite and offsite, and present and past consequences of LD) and recognizing both relevant natural and anthropogenic causes of LD. Moreover, farmers' awareness embraces the holistic nature of their land resources. Although farmers feel high moral responsibility for the causes of LD, they feel low or partial moral responsibility to take action to halt LD.*

Value: *The empirical evidence provides a basis for policymakers to avoid stereotyping of land-users as ignorant of LD in conservation interventions, thus suggesting to consider possible other factors affecting farmers' conservation behavior.*

Keywords: *Conservation, Land degradation neutrality, Perception, Sustainable land management*

INTRODUCTION

Land degradation (LD) is an age-old problem that involves the decline of soil, vegetation, and water resources. Despite its historical presence, LD remains a pressing environmental concern that significantly impacts the well-being of both humanity and ecosystem services across the globe (IPBES, 2018; Prăvălie *et al.*, 2021).

It has been estimated that the rise of demand to feed almost 10 billion of the world's population in 2050 could elevate LD, particularly in developing countries while bringing USD23 trillion loss to the global economy (IPBES, 2018; UNCCD, 2018; Fróna *et al.*, 2019). Five LD processes namely aridity, vegetation decline, soil erosion, soil salinization and soil organic carbon decline had having major impact on land productivity.

Among these processes, aridity and soil erosion were found to individually affect approximately 40% and 20% of global arable systems, respectively. These two degradation processes simultaneously affect an additional 7% of global arable lands, making it the dominant synergy among LD processes in arable lands worldwide (Prăvălie *et al.*, 2021).

[1]Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura.
[2]Department of Regional Development and Management Studies, Faculty of Agriculture, Saga University, Saga, Japan.
*chinthbk@agri.rjt.ac.lk
https://orcid.org/0000-0002-6209-4722

Land degradation in Sri Lanka is primarily attributed to the conversion of forests and grasslands into agricultural and plantation crops, coupled with inadequate land management practices (Ministry of Mahaweli Development and Environment, Sri Lanka, 2017). Among the various LD processes in the country, soil erosion caused by water has been identified as the main contributing factor. Interestingly, contrary to previous beliefs, a significant proportion of degraded land is observed in the dry zone of the country, as opposed to the wet zone (Ministry of Mahaweli Development and Environment, Sri Lanka, 2017).

The Dryzone, covering two-thirds of the land area, features a distinctive landscape known as the Cascaded Tank Village System (CTVS). This system is an integral part of Sri Lanka's hydraulic civilization, and it involves the interconnection of small man-made reservoirs designed to capture seasonal rainwater. These interconnected reservoirs serve various essential purposes, including supporting agricultural activities, providing water for households, and contributing to environmental conservation efforts. The CTVS holds exceptional significance as a longstanding socio-ecological system in Sri Lanka that has facilitated agriculture, supported the environment, and benefited humanity (Abeysingha *et al*., 2018; Dharmasena, 2020). As a result of its profound contributions, the CTVS is recognized as a Globally Important Agricultural Heritage System (FAO, 2018).

Components of a CTVS can be recognized in four distinctive zones 1) rain-fed upland (rain-fed upland farms and forest in the catchment), located just above the tanks and 2) tank bed and bund; 3) irrigation channels and paddy fields and 4) hamlet (Geekiyanage and Pushpakumara, 2013). The CTVSs are susceptible to various land degradation processes due to a combination of natural and human activities.

Rain-fed uplands comprised with rain-fed upland farms and forests in the catchment are mainly exposed to soil erosion, soil fertility decline and deforestation LD processes. Studies indicate that unsustainable farming practices and inadequate soil conservation efforts are the primary factors contributing to soil erosion and soil fertility decline. These issues lead to reduced upland productivity and increased sedimentation in low-lying small tanks (Abeysingha *et al*., 2018; Kulasinghe and Dharmakeerthi, 2022). Besides that, the rapid deforestation due to encroachment in rain-fed or catchment areas has resulted in decreased Net Primary Production (how much carbon dioxide vegetation takes in during photosynthesis minus how much carbon dioxide the plants release during respiration) of the dry zone (Fernando *et al*., 2015; Ministry of Mahaweli Development and Environment, Sri Lanka, 2017). As a result, the sustainable existence of CTVS, domestic food security, rural economy, and ecological sustainability of the region have been threatened. Therefore, suitable measures are promptly needed to neutralize the LD in Rain-fed uplands of CTVS.

The peoples' awareness and responsibility toward environmental issues play a crucial in mitigating and neutralizing those issues. American Psychological Association depicts awareness as a person's accurate reportability of something that person has perceived or knows. Applying popular theoretical models such as Norm Activation Model and Value-Belief-Norm (Schwartz, 1977; Schwartz and Howard, 1981; Stern *et al*., 1999), studies have recognized that peoples' awareness of environmental consequences is a key antecedent of the psychological process of environmental behaviors (Johansson *et al*., 2013; Rezaei *et al*., 2019). In this regard, land users' awareness of the consequences of LD would be a critical antecedent of their actions towards neutralizing LD. Previous studies have attempted to investigate farmers' awareness of LD, particularly the LD processes such as soil erosion and soil fertility decline (Okoba and Sterk, 2006; Odendo *et al*., 2010; Bewket, 2011; Kuria *et al*., 2019; Tesfahunegn, 2019). In these studies, it has been evident that farmers are aware of LD processes including their underlined reasons and consequences. Farmers have perceived those issues by both biological indicators (E.g., reduced crop performance, presence of weeds that are unique in degraded lands) and physical indicators (E.g., soil sedimentation in reservoirs and water canals, soil becoming coarse and soil color becoming pale). Despite complex analytical protocols or mathematical formulas as it is in scientific approaches to confirm the accuracy of perceived LD, comparing perception with available scientific evidence found that perceived indicators closely overlap with scientific findings in many instances (Okoba and Sterk, 2006). Moreover, those land users have recognized both anthropogenic and natural causes as the underline reasons for their perceived LD processes. Furthermore, some of these studies have elaborated on how the awareness of land users has benefited various other activities. For example, to evaluate the severity of LD (Okoba and Sterk, 2006; Moges and Holden, 2007; Bewket, 2011; Kuria *et al*., 2019) and to implement appropriate conservation strategies even without government support (Joshi *et al*., 1996; Kuria *et al*., 2019). However, sometimes it has been shown that land users' awareness of LD may not lead to conservation attempts possibly due to other factors which are beyond their control (Moges and Holden, 2007; Bewket, 2011).

Responsibility toward the environment can be ascribed by individuals and institutions. However, it is still controversial to what extent it is reasonable to share the responsibility for the environment with individuals and institutions. Studies have cited that ascribing responsibility not only to individuals but also to institutions like government and corporations is necessary for increasing the chances for society to act in an environmentally friendly way (Fahlquist, 2009). The individual's responsibility or ascription of responsibility is a significant antecedent of the psychological process of environmental behaviors(Rezaei *et al*., 2019; Kim and Hwang, 2020). In general, an individual's responsibility toward the environment is recognized in two folds i.e. conventional and moral (Kaiser and Shimoda, 1999). Moral responsibility is the person's judgment that he/she is morally responsible for his/her behavior which arises from exercising certain powers and capacities attributed to that person (Talbert, 2019). Conventional responsibility, on the other hand, explains a person's responsibility for others such as authorities, often for receiving positive feedback. However, studies suggest that people feel morally rather than conventionally responsible for environmental behaviors (Kaiser and Shimoda, 1999). Often people who ascribe responsibility for environmental issues to them are more likely to sacrifice for the environment than those who ascribe it to others (E.g., the government) (Chen and Zheng, 2016).

Unsustainable farming practices and inadequate soil conservation efforts in rain-fed uplands of CTVS are linked to the irresponsibility and lack of awareness among land users, serving as the primary reasons for the problem (Samaratunga and Marawila, 2006; Ministry of Environment and Renewable Energy, Sri Lanka, 2014). To address these issues, it is crucial to raise awareness and advocate for responsible land management practices. However, it should be noted that these judgments regarding land users' irresponsibility and unawareness are not strongly supported by sufficient empirical evidence. In such cases, the labeling of land users as irresponsible and unaware may be based on unfounded stereotypes. As previously discussed, it is possible that land users have their own understanding of LD processes, which might differ from the scientific perspective. Moreover, they may not feel personally responsible for the LD and may believe that the causes and solutions are beyond their control. Considering these concerns, the authors question the accuracy of assuming farmers' unawareness and irresponsibility regarding LD. Therefore, there is a need to further investigate and understand the perspectives of land users to assess their actual level of awareness and responsibility in addressing LD. Therefore, this study is aimed at providing empirical evidence on farmers' awareness of LD by investigating farmers' perceived indicators and causes of LD i.e., deforestation, soil erosion, soil fertility decline, and their perceived responsibility to halt LD. Additionally, this study is also focused on analyzing any land-use changes in the targeted area during the past to recognize any significant changes.

MATERIALS AND METHODS

This study was conducted in five purposefully selected Grama Niladari Divisions, i.e. *Thurukkaragama, Mahakiribbewa, Kokmaduwa, Bethkewa,* and *Ranpathwila* in *Ranpathwila* CTVS in the *Kahatagasdigiliya* divisional secretariate, dry zone of Sri Lanka. In *Ranpathwila* CTVS, land users are readily accessible and have been less exposed to similar investigations compared to other CTVSs. Additionally, they have received minimal training and awareness programs on LD in comparison to their counterparts. According to the 2018 records, the selected administrative divisions had 1,377 farmers who engaged in rain-fed upland farming. A questionnaire survey was administered in March 2019 among 291 farmers. A pretested structured questionnaire including questions for farmers to provide multiple responses on indicators and causes of deforestation, soil erosion, and soil fertility decline was included. Then the questionnaire was translated into the local language that is common in the study area.

The content and face validity of the questionnaire were assured by experts in agricultural extension. Face-to-face interviews and field observations were conducted by the principal researcher and a team of 4th-year agricultural undergraduates who were experienced in the dry zone ecosystems. The voluntary participation of the responding farmers was acknowledged with a token of appreciation. Finally, data were analyzed using descriptive statistics, including multiple response analysis in the SPSS (Statistical Package for the Social Sciences) Version 18.0. Rain-fed upland farms were formerly under subsistence-oriented shifting cultivation where limited external agricultural inputs were used. Gradually these shifting farms were changed to settled commercial mono-cropping systems which use many external inputs like synthetic fertilizers and hybrid seeds. In the *Ranpathwila* CTVS area, commercial-oriented rain-fed farming became visible around two decades ago. Assuming that period was critical to the LD of the study site, land use images on 17th July 2000 were compared with images on 27th July 2018. This study adopted supervised classification with a maximum likelihood algorithm in ERDAS imagine for classifying land use/cover under six classes through supervised classification in ERDAS 2014 software.

RESULTS AND DISCUSSION

Land-Use Change in the Ranpathwila CTVS Around Two Decades

The results (Fig.01.) revealed that around the last two decades, the extent of several land uses has considerably increased while being compensated by a decrease in the extent of other land uses. Sparse croplands have gained the highest extent (85%) during the last two decades followed by built-ups (35%) and paddy fields (4%). The extent under vegetation (50%) got highly diminished, followed by the area under forests (40%) and tanks (15%).

Land-use change indicates that the rapid swap of the land extent under vegetation and forest use to sparse croplands and buildups is probably associated with the rapid expansion of rain-fed upland farms and the area under dwelling structures. It can be argued that the rapid expansion of rain-fed upland farms during the past two decades is possibly associated with maize cultivation (Fernando *et al.*, 2015). Possible reasons for the extensive cultivation of Maize have been discussed in the following sections.

Background Characteristics of Farmers and Their Farming Practices in Rain-Fed Uplands.

According to Table 01, many responded farmers in this study area were elderly males, who possessed secondary or higher education levels and nearly 27 years of experience in farming. Farming was their primary employment, while for others, it was secondary employment. They had at least one parcel of land from both upland and lowland that extent about two acres.

Results (Table 02.) revealed that rain-fed farming is conducted in two seasons, i.e. *Maha* season and the *Yala* season. The former gets an abundance of rainwater and enables farming for many farmers, while the latter gets less rainwater and fewer opportunities for farming. The less popularity of cultivating rain-fed farms during the *Yala* season is possibly due to the limited rain-water availability during this season. Moreover, it indicates that farmers possibly have no or limited access to other water sources such as groundwater from agro-wells. This can be further understood as *Yala* cultivators mainly attempt to cultivate drought-tolerant crops such as sesame (Dissanayake *et al*., 2019).

Many farmers' intention of rain-fed farming was to earn cash income while for a few farmers, it was still for subsistence. Maize was the extensively cultivated crop by many farmers in the *Maha* season while sesame was the popular crop among farmers who cultivate *Yala* season. Extensive cultivation of Maize in the *Maha* season in rain-fed uplands mainly due to commercial purposes. Farmers choose Maize mainly for profit maximization (Weerahewa and Dayananda, 2023) as the market demand for maize by industries such as animal feed and ready-mixed cereal (Esham, 2014). Furthermore, extensive cultivation has been facilitated by mechanization in land preparation.

According to results and field observations, the majority of farmers have ploughed their farmlands using hired four-wheel tractors which are mounted with disk ploughs. Machinery usage for land preparation is possibly due to a lack of cheap labor in the main cultivation season. This is perhaps due to the labor migration from the agriculture sector to other industrial and service sectors for attractive job opportunities. Thus, it can be assumed that the use of machinery could become the new normal in future rain-fed upland farming.

However, field observations revealed that farmers are less concerned about aspects such as ploughing direction as some farmers ploughed their lands along the slope. Moreover, it has been observed that there are no or limited attempts to conserve soil. Deep plowing up to 45cm is recommended for maize that has deep growth, and drainage of excess water is highly encouraged during heavy rain periods[2]. Disk plowing facilitates the recommended plowing depth yet the lack of concern for soil conservation would amplify the water erosion in deeply ploughed lands during the heavy rains. Although lands that are ploughed along the slope facilitate drainage of excess water during heavy rainy seasons, it would accelerate the runoff and increase water erosion unless appropriate soil conservation strategies are not placed (Lindstrom *et al.*, 1990).

It was also observed that popular crops such as maize, sesame, and chili were planted in a mono-cropping pattern and paddy was cultivated only in water logging areas which sometimes include the upper parts of the tank boundary. Discussion with farmers revealed that they have a high tendency to use synthetic fertilizers for crops that are grown for commercial purposes.

According to the results, many farmers have used three types of straight synthetic fertilizers for maize (urea, muriate of potash and triple supper phosphate). The government recommended fertilizer application rate for rain-fed maize cultivations (Kg/acre) Urea=90, TSP=40, MOP=20 (Department of Agriculture Sri Lanka, n.d.). The average applying rates of muriate of potash (46.97Kg/acre) and urea (149.32Kg/acre) for maize were approximately 134% and 67% higher than the government-recommended level consecutively while triple superphosphate (39.53Kg/acre) was around the government-recommended rates (40Kg/acre) (Table 2). Applying rates of these fertilizers were widely distributed among respondents (Table 2).

The application of synthetic fertilizer is a plus point for maintaining soil fertility, and it is probably supported by the government fertilizer subsidy program (The Government of Sri Lanka, 2018). However, its widely distributed application rates create doubt about the usefulness of applied fertilizer and farmers' concerns about government-recommended rates. Perhaps farmers are unaware of recommended rates (Aryal *et al.*, 2021) for their lands or they are using their rates due to other reasons such as unawareness of the exact land extent they cultivate and assuming that the quality of fertilizer is low.

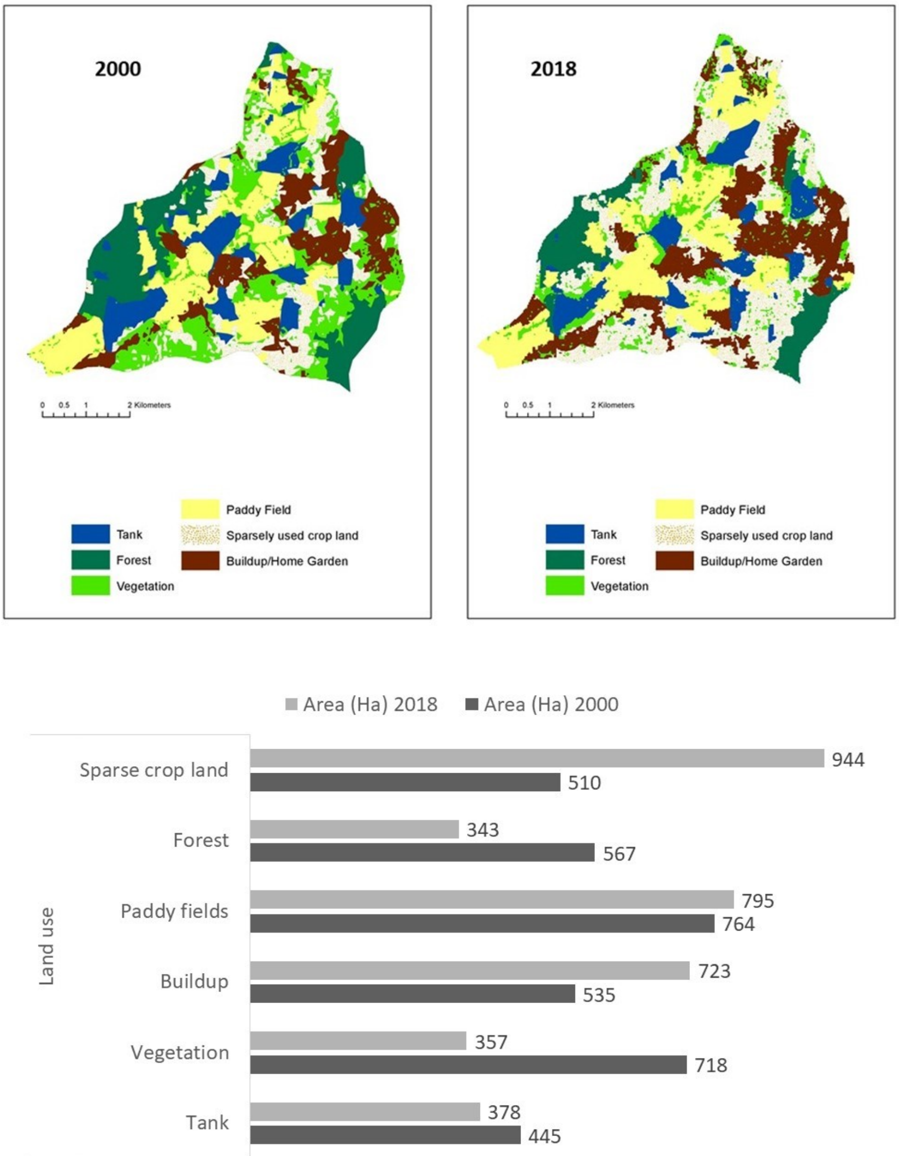

Figure 01. Land-use change in *Ranpathwila* cascaded tank-village system from 2000 to 2018.

(Source: Satellite image data of Landsat 7 on 17th July 2000 and Landsat 8 on 27th July 2018)

Farmers' Awareness of Land Degradation

The main objective of this study was to investigate farmers' awareness of LD that occurs in rain-fed uplands in the CTVS of the dry zone. For that farmers' perceived indicators for causes of land degradation were revealed as follows.

Results (Table 03.) found that on average, a farmer could mention one deforestation indicator and two soil erosion and fertility decline indicators. A similar pattern of responses was obtained for their perceived causes for those issues.

Deforestation: According to the results (Fig.02.), farmers mentioned eight indicators for deforestation. They were mainly associated with changed land use, meteorological conditions, and animal behaviors. The most frequently cited indicator was the increased extent of rain-fed upland farms (34%) followed by water scarcity (22%) frequent droughts (19.4%), changes in rainfall pattern (13.9%) and few others (10.5%) such as elephant encroachments, and reduction of wildlife. Among those indicators, many farmers (52.3%) have mentioned the increase of croplands in uplands as a deforestation indicator.

Farmers have perceived that deforestation is associated with five causes (Fig.02.). Among them, encroaching for cultivation (70.7%) was the highest perceived cause followed by illegal timber felling (27.8%) and a few others (1.6%) such as settlement and population growth. Among perceived causes, nearly 90% of farmers cited encroaching forests for cultivation as a cause of deforestation.

Soil erosion: As results found (Fig.03.), farmers mentioned 14 indicators of soil erosion. Many of these indicators were associated with onsite impacts of water erosion while few were associated with offsite impacts of water erosion. Among these indicators muddy runoff during rainstorms (29%) was the most frequently cited indicator followed by the reduction of the topsoil layer (23.1%), the increase of soil gravelliness (20.3%), sedimentation of tanks (10.3%) and ten other indicators such as soil hardness, expose of bottom soil layers and rill formation. The majority of farmers have mentioned muddy runoff during rainstorms (65.1%) and reduction of the topsoil layer (51.8%) as indicators of soil erosion. Meanwhile, nearly half of the farmers (45.6%) mentioned the increase in soil gravelliness as another indicator.

Table 1: Background characteristics of farmers

Particulars	n	Value
The average age in years (SD)	287	51.86 (10.95)
Gender (%)		
Male	243	83.5
Female	48	16.5
Education level (%)		
Primary or less	53	18.7
Secondary level	188	66.4
Advanced level or higher	42	14.8
The average farming experience in years (SD)	249	26.81 (13.55)
Farming (%)		
Primary employment	240	82.5
Secondary employment	51	17.5
Number of upland parcels (%)		
One	232	86.6
More than one (2-4)	36	13.4
Number of lowland parcels (%)		
One	176	66.4
More than one (2-8)	89	33.6
The average total extent of uplands in acres (SD)	267	2.14 (3.00)
The average total extent of lowland in acres (SD)	263	2.06 (2.07)

(Authors' field survey 2019)
Note: n= number of respondents

Table 2: The current farming practices in rain-fed uplands

Particulars	n	Value (%)
Main crops cultivated in the Maha season	(n=261)	
Maize only		75.1
Paddy only		12.3
Maize with paddy/finger millet		4.2
Others (E.g., finger millet, sesame, vegetable, condiment, pulses)		8.4
Main crops cultivated in the Yala season	(n=120)	
Sesame		58.3
Vegetables or condiments		16.7
Paddy		10.4
Others (E.g., finger millet, maize)		14.6
Purposes of cultivation	(n=252)	
Selling only		83.7
Consumption only		11.9
Selling and consumption		4.4
Land preparation methods	(n=255)	
Four-wheel tractor disk plough only		93.7
Two-wheel tractor rotavator only		2.0
Tractors and hoes		4.0
The average fertilizer usage for maize (kg/acre)		
Urea (n=198)		149.32 (90.97)
Muriate of potash (MOP) (n=181)		46.97 (27.80)
Triple superphosphate (TSP) (n=184)		39.53 (21.85)

(Authors' field survey 2019)
Note1: n= number of respondents
Note 2: Paddy was cultivated in water-stagnating upland areas.

Table 3: Descriptive results of land degradation indicators and causes.

Land degradation type	Indicators					Causes				
	n	*N*	*Mean*	*Median*	*Range*	*n*	*N*	*Mean*	*Median*	*Range*
Deforestation	260	396	1.52	1	1–4	250	317	1.27	1	1–2
Soil erosion	272	611	2.25	2	1–7	273	542	1.99	2	1–5
Soil fertility decline	275	498	1.81	2	1–5	273	492	1.80	2	1–6

Note: *n* = number of respondents, *N* = number of responses.
(Authors' field survey 2019)

Farmers have perceived 13 causes that are associated with soil erosion (Fig.03.). Eight of them were related to farming practices or related human activities, and the rest were associated with natural reasons, i.e. meteorological conditions and land characteristics. The absence of soil conservation measures (26.1%) was the most frequently cited cause of soil erosion followed by the slope (23.5%), deforestation (13.1%), nature of the soil (12.4%) and several others. The majority of farmers (51.6%) have cited the absence of soil conservation as a reason for soil erosion, while nearly half of farmers (46.5%) have mentioned slope as another cause.

Soil fertility decline: According to the results (Fig.04.), farmers mentioned 11 indicators of soil fertility decline. Many of them are associated with plant performance, followed by soil conditions and farm income. The most cited indicator was low crop performance (yield/growth) (43%) followed by low plant response to added fertilizer (18%), low vigor in plants around the farm (16%), paling of leaf colors (13.9%) and several others such as reduction of soil color and soil becoming sandy. The majority of farmers (77.5%) have cited low plant performance as an

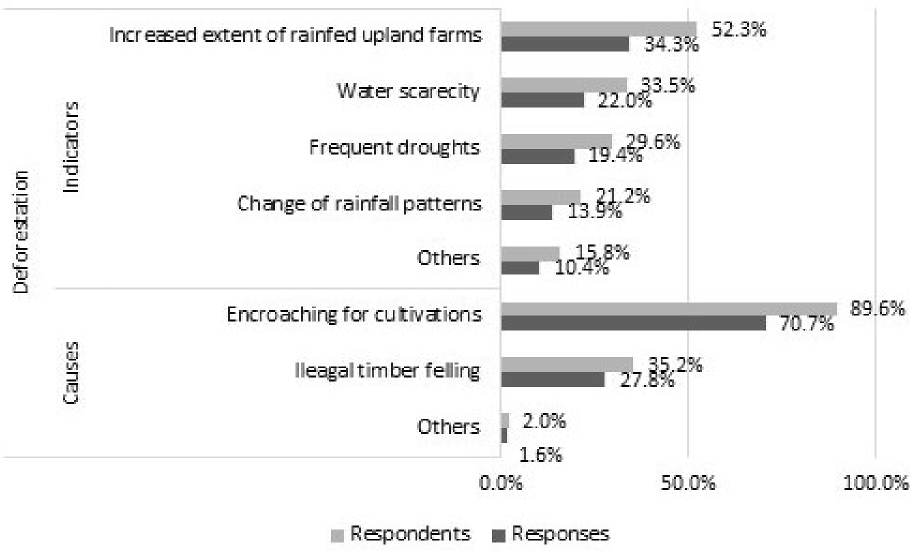

Figure 02. Perceived indicators and causes of deforestation
(Authors' field survey 2019)
Note: Other indicators include current forest extent compared to past, elephant encroachments, reduction of wild animals and intense sunlight. Other causes include settlement, population growth and political influences

indicator of soil fertility decline.

Farmers have perceived 15 causes of soil fertility decline (Fig.04.). Many of those causes are related to fertilizer applications followed by cropping patterns, other types of LD, i.e. soil erosion and deforestation, and residue management. The most frequently cited cause was soil erosion (40.4%) followed by the cultivation of the same crop for a long period (21.5%) heavy application of inorganic fertilizers (10.2%) and several others such as the burning of crop stubbles and low or absence of organic fertilizer application. The majority of farmers cited (72.9%) soil erosion as an indicator of soil fertility decline.

According to the results indicated above, farmers are aware of LD in their ways. Perceived indicators imply that the farmers' recognition of LD is mainly qualitative assessments based on their physical examinations (E.g., visually observed and touched). Some of these physical examinations can be identified as onsite and offsite consequences (E.g., muddy runoff as onsite and low plant growth as offsite soil erosion indicators) or current and past consequences (E.g., muddy runoff as current and sedimentation as a past consequence of soil erosion) of LD. Farmers' perceived causes of LD indicate farmers' concern not only about natural factors but also about anthropogenic factors which are closely associated with farming practices. Farmers' perceived causality among kinds of LD (E.g., soil erosion as a cause of soil fertility decline and deforestation as a cause of soil erosion) indicates that farmers are aware of interlinkages between kinds of LD, thus implying their holistic view of the land resource. Similar indicators and causes are found in other studies conducted in different localities (Okoba and Sterk, 2006; Moges and Holden, 2007; Odendo *et al.*, 2010; Bewket, 2011; Yiran *et al.*, 2012; Fernando *et al.*, 2015; Twongyirwe *et al.*, 2018; Kuria *et al.*, 2019).

Findings indicate that the most perceived indicators are associated with certain contextual factors such as farmers' proximity to the forest, morphological characteristics of the soil, and the condition of the farmland. Cropland expansion, the most frequently cited deforestation indicator is probably due to farmers' proximity to the forest. The forest is a primary component in the traditional tank-village system (Dharmasena, 2010); thus, it is in the vicinity of farmers' hamlets and farms. Since farmers' activities were completely linked with the outdoor environment, their focal attention on vegetation changes in the forest is probably unavoidable. Although this study highlighted the farmers' qualitative assessment of deforestation, some similar findings cited that living in the forest vicinity can make farmers aware of both qualitative and quantitative degradation of the forest (Yiran *et al.*, 2012).

Washing off the soil as the most cited indicator of soil

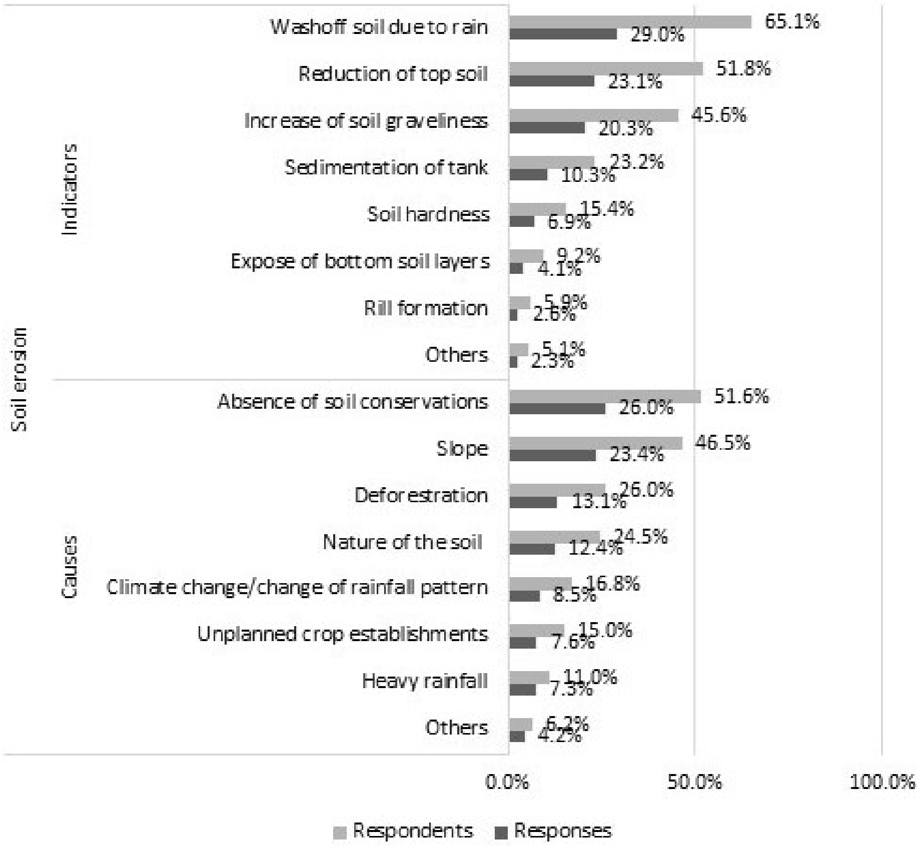

Figure 03. Perceived indicators and causes of soil erosion.
(Authors' field survey 2019)
Note: Other indicators include flood, exposure of roots, sedimented canal, levelled slopes, low plant growth, low soil fertility, and loosed soil. Other causes include heavy tillage, unmanaged drainage, weedicide application, drought, lack of attention, cattle trampling

erosion is possibly due to the characteristics of the soil available at the study site. The most abundant soil group in the study site is known as Reddish-Brown Earth which is dark brown to dark reddish-brown, highly erodible due to weak aggregation and has a typical subsurface gravel (quartz) layer (Dassanayake *et al.*, 2020; Indraratne, 2020). During a rainstorm, it is highly probable for this soil to be eroded while producing reddish muddy runoff which can be easily detectable at the time when it is happening (Jayasekara *et al.*, 2018). This indicator was contrary to the most perceived soil erosion indicators (i.e. broken soil water conservation structures and coarser soil) of previous studies (Okoba and Sterk, 2006; Moges and Holden, 2007). This contrary is perhaps due to the different focal attention given by different land users in different localities. For example, people in hilly areas might be more concerned about broken soil and water conservation structures to detect soil erosion, whereas people who live in coastal areas might know how much land area that lost to the sea.

Crop performance as the most cited indicator of soil fertility decline seems to be due to its suitability as a bio-indicator. Bio-indicators are found to be reliable indicators that can provide immediate feedback on the existing soil fertility (Kuria *et al.*, 2019). Despite being in different localities, farmers in other communities also found crop performance as their popular indicator to detect soil fertility decline (Moges and Holden, 2007; Odendo *et al.*, 2010). When farms are mostly occupied with crops rather than other vegetation, crops possibly become a suitable candidate for farmers to understand the soil fertility level.

The most perceived causes of LD are anthropogenic. Forest encroachment for cultivation is the most perceived cause of deforestation whereas the absence of soil conservation can be identified as the most perceived cause of both soil erosion and soil fertility decline as soil erosion is the most perceived cause of soil fertility decline. These causes have already been identified in previous studies (Dharmasena, 1994;

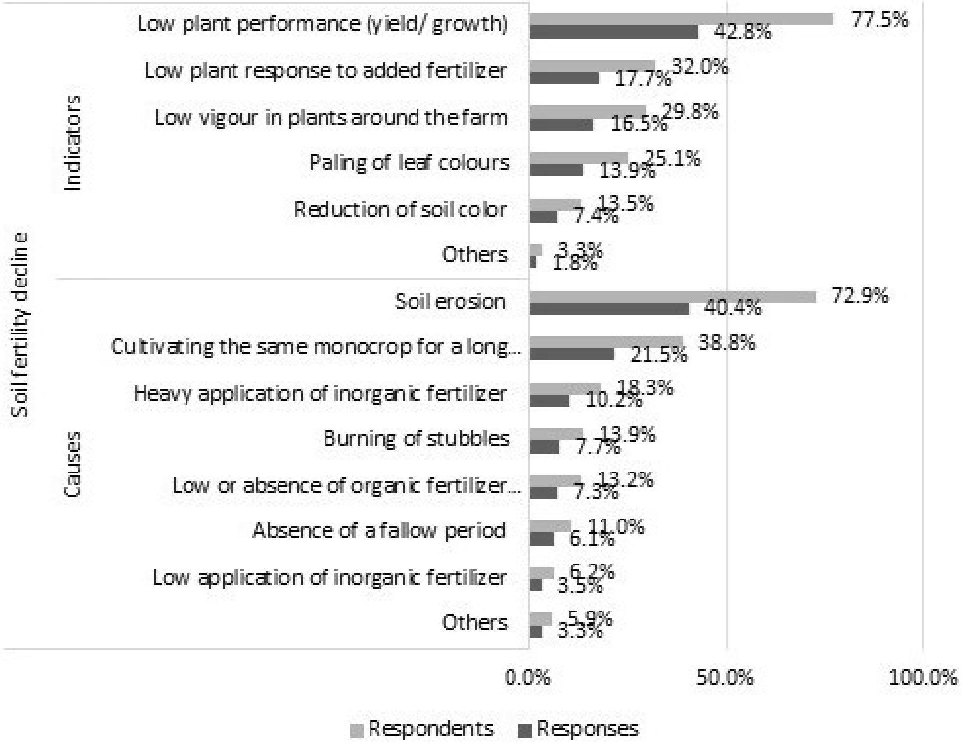

Figure 04. Perceived indicators and causes of soil fertility decline (Authors' field survey 2019)
Note: Other indicators include soil becoming sandy, low income, dry soil, many weeds, hard soil, and many plant diseases. Other causes include agrochemical, low microorganisms, deforestation, exposure soil to sunlight, soil gravels, natural depletion, lack of rain, removal of crop residues

Ministry of Environment and Renewable Energy, Sri Lanka, 2014; Fernando *et al.*, 2015). Consistent with this study, some farmers in other communities in other localities have perceived anthropogenic causes as the main reasons behind deforestation, soil erosion and soil fertility decline (Moges and Holden, 2007; Twongyirwe *et al.*, 2018). However, there are also contrary findings in other communities that have perceived natural causes as the main reasons behind the abovementioned issues (Okoba and Sterk, 2006; Bewket, 2011). This is perhaps due to the influence ability of anthropogenic or natural factors relevant to the LD in that particular area. For example, even though the soil in the dry zone is highly susceptible to erosion due to the low aggregability of the soil and rainfall (Moorman and Panabokke, 1961; Jayasekara *et al.*, 2018), a study by Dharmasena (1994) has emphasized that low vegetation cover and the absence of soil conservation can result in severe soil erosion. In this respect, it could assume that many farmers perceive the causes that have high influenceability on the LD in a particular landscape.

Farmers' Moral Responsibility for Causing and Halting Land Degradation

To understand whether farmers are in control of LD, farmers were requested to mention who is mainly responsible for the causes of deforestation, soil erosion and soil fertility decline and for taking actions to halt them. Among various responses given by farmers, three responsible parties were identified as farmers, the government and others. According to Table 04, the majority (76%) accepted that farmers are responsible for causing deforestation, soil erosion and soil fertility decline. However, when it comes to action to halt those issues, farmers have perceived that both them (42%) and the government (57%) are responsible for it.

Results of farmers' perceived responsibility for the causes of LD suggest that they willingly accept that their actions are responsible for LD. Findings in the previous section also support the fact that farmers perceived many causes of LD are associated with farming practices. However, their perceived responsibility for actions to halt LD indicates that

Table 4: Farmers' perceived responsibility for causing and halting land degradation in rain-fed uplands.

Particulars	Farmers		Government		Others		Total Responses	
Perceived responsibility for causing LD	233	76%	57	19%	16	5%	306	100%
Perceived responsibility for halting LD	147	42%	195	56%	6	2%	348	100%

Authors' field survey, 2019. **Note:** LD = Land Degradation.

they are not willing to take full responsibility for it but would like to share it with the government.

Concerning moral responsibility that people ascribe to themselves, particularly in environmental behaviors (Kaiser and Shimoda, 1999), it can be assumed that the farmers believe they possess the necessary powers and capacities for causing LD while they believe the power and capacities for halting LD are associated with them and the government in an equal manner (Talbert, 2019).

Even though some previous studies suggested that people who ascribe responsibility for environmental issues to them are more likely to sacrifice for the environment than those who ascribe it to others (E.g., the government) (Chen and Zheng, 2016), the findings of this study could not justify this link as it could not observe suitable actions to halt degradations. Perhaps farmers may have not perceived those issues as severe due to their myopic understanding of the potential future consequences of LD (OECD, 2012, p. 12). Or else they may not have suitable resources and competencies for voluntary actions, thus expect support from other parties like the government.

CONCLUSIONS

Farmers are aware of LD in their way. It is mainly based on physically examining and qualitatively assessing the relevant indicators of LD and recognizing both relevant natural and anthropogenic causes of LD. Moreover, it embraces the holistic nature of their land resources. Although farmers feel a high moral responsibility for the causes of LD, they feel a low or partial moral responsibility to take action to halt LD, possibly due to difficulties with voluntary solutions. Finally, the study recommends policymakers to avoid stereotyping land users without evidence and investigate possible factors and mechanisms that affect land users' behavior for neutralizing LD.

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